

# Navajo Technical University

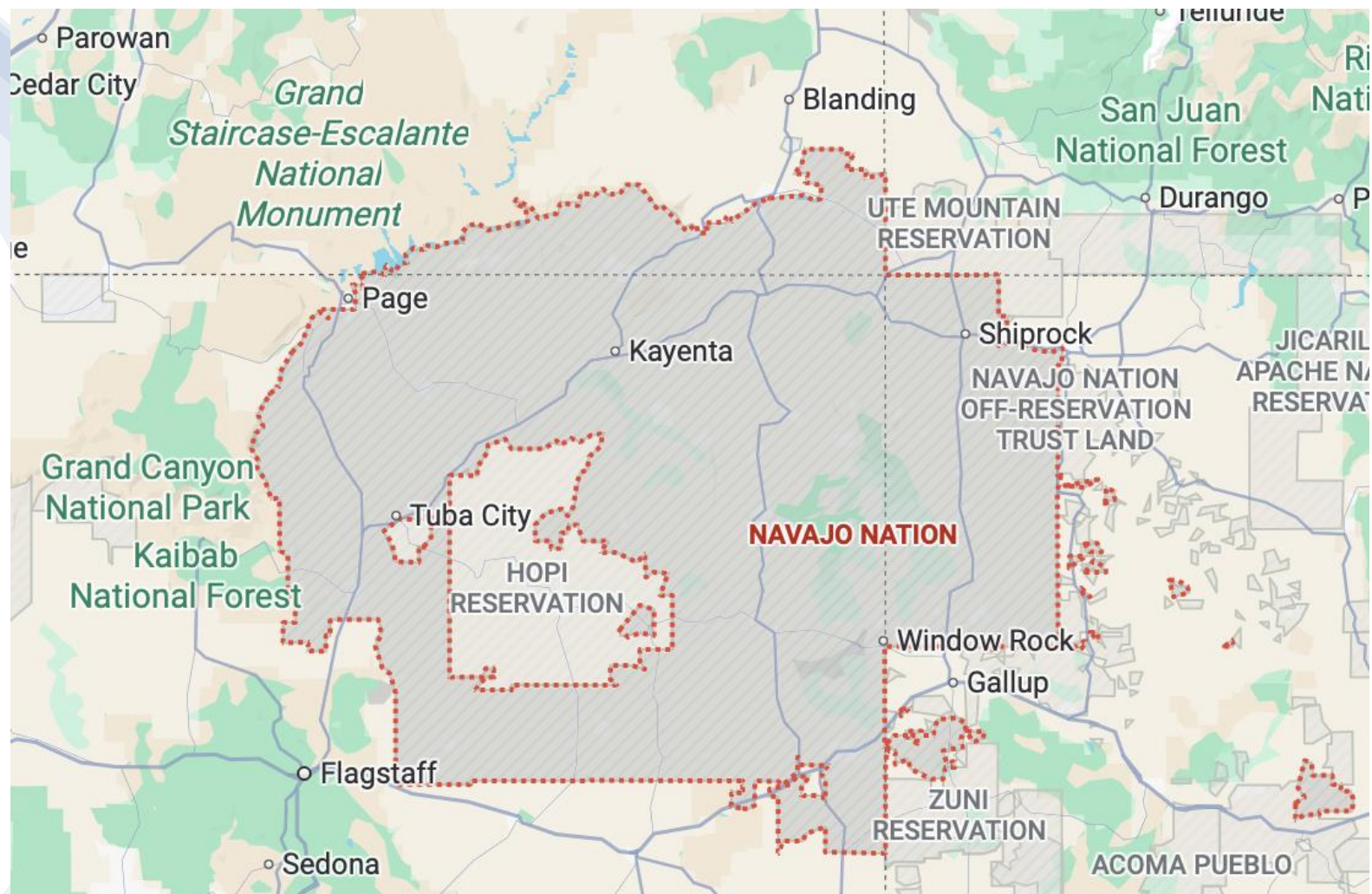
Dr. Sundaram Arumugam

Associate professor

Electrical Engineering



# Navajo Nation



# Energy availability is a significant challenge in the Navajo Nation

Approximately 13,000-14,000 house lacking electricity

- vast geographical distances
- Poverty
- high connection costs

Residents often rely on alternative power sources like

- kerosene
- diesel generators
- solar panels

# Solar panels - Navajo nation

Solar panels  
for Navajo  
Nation houses  
are sponsored  
by a  
combination.

- Federal, state, and private entities, including
- U.S. Department of Energy (DOE)
- U.S. Department of Agriculture (USDA),
- Private companies like Qcells and Navajo Transitional Energy Company (NTEC), and non-profit organizations such as Native Renewables.
- These sponsors provide grants, equipment donations, and funding for installation to electrify homes.

# Navajo Technical University

Certificate Programs

Associate programs

Bachelor Degree Programs

Masters Degree Programs

PhD Program

# NTU Electrical Engineering

B.S.EE – ABET Accredited program

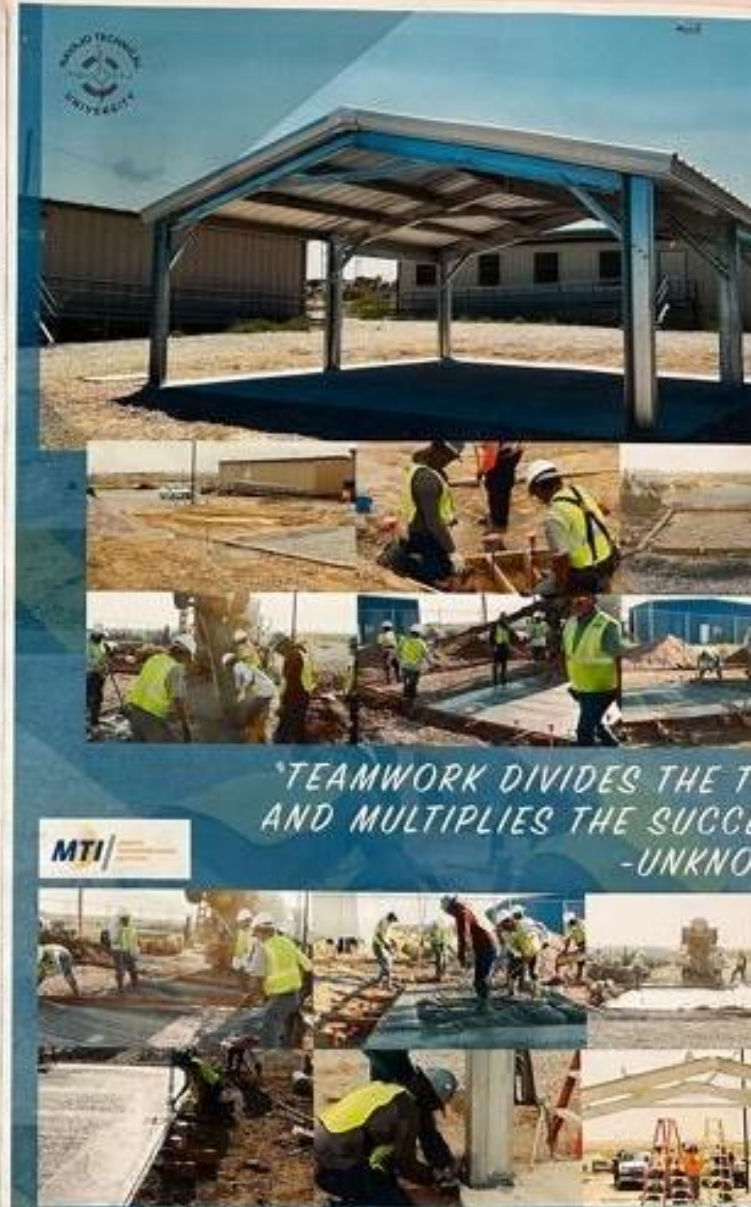
M.S.EE – HLC Approved

PhD – Yet to Start



# Navajo Technical University

- Construction of Gazebo at NTU campus with Solar Panels





A Study on a Solar Panel installation and Operation as a part of curriculum at a Navajo Nation House.

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# U.S. Department of Energy's Solar Decathlon Competition

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- Electrical student Edwina Lesli Presented the design paper in the completion
- Martin Keller, The director of National Renewable Energy laboratory and With David M.Turk Deputy Secretary of the US Department of Energy.




# “Off-Grid Solar Powered system implementation on the Navajo Nation”



## Off-Grid Solar Powered system implementation on the Navajo Nation.

Strawberry Livingston<sub>1</sub>, Dr. Henry Louie<sub>2</sub>,  
Electrical Engineering Department, Navajo Technical University<sub>1</sub>,  
Seattle University<sub>2</sub>



### Abstract



Approximately 30 percent of the population on the Navajo Nation (NN) are still without electricity<sup>1</sup>. Connecting a home to the electrical grid on the NN has an average cost of about \$40,000<sup>2</sup>. This cost only reflects towards existing distribution lines near homes that require minimal materials and personnel to implement these connections. These prices increase exponentially as distribution lines distance increase from the homes that need electrification. Since the four corners region has an exceptional isolation for Photovoltaic (PV) arrays, this could give the NN the ability to become an Energy sovereign nation and help support energy sustainability as a community or even individuals that are remote from main grid connections.

### Introduction

As an objective for this project, students were required to create a company to implement a PV system at any location selected by the student. Companies were given a budget of \$50,000 for material to establish a PV system for a new home, commercial business or other establishments that can stay within the budget. These systems must relate to real life situations such as a selection of location, average daily loads, selection of inverter, battery bank selection, charge controllers, tilt and insulation, PV module selection and prices of components.

### Method

- Fig. 1 shows an image of the proposed location in Broadspings, New Mexico. The image is taken from Google Earth Pro to give reference the location to obtain the latitude and longitude, which was used to find the insulation of the area utilizing the NASSA POWER prediction application.
- Latitude and Longitude of the location is, 35° 24' 03.25" N; 108° 43' 24.93"



### Abstract


An intuitive approach was taken to calculate the Average daily load calculation. The load is calculated by listing all appliances that are within the household and all rated power consumption of the appliances in watts (W). Each appliance's wattage is multiplied by the number of units that are inside the home. The wattage is then multiplied by the estimated number of hours utilized within a 24-hour period. The product of Watts x Hours gives the value of Watt-hours used per Day (Wh/Day).

### Method

- Capacity factor =  $\frac{\text{Average Insolation during December}}{24 \text{ hours}}$
- Daily energy production =  $E_p = 24 \times \text{capacity factor} \times P_{\text{pv}}$ , rated
- $P_{\text{pv, rated}} = \frac{\text{Average Daily Load}}{24 \times \text{capacity factor of inverter}}$
- $P_{\text{pv, rated}} = \frac{\text{Avg. Daily Load}}{1 - \text{efficiency}}$
- $P_{\text{pv, rated}} = 100\% \times \frac{\text{Avg. Daily Load}}{100 - \text{efficiency related}}$
- $P_{\text{pv, rated}} = \frac{\text{Avg. Daily Load}}{1 - \text{efficiency}}$
- Number of Array strings =  $\frac{P_{\text{pv, rated}}}{\text{module Watt rating}}$

### Tilt and Insulation

- The tilt and insulation were determined using open source applications. The two applications were Google earth pro and NASA access-data-viewer. The insulation's are categorized into three sections. The first is the tilt information at degree of latitude which is 35 degrees and a minus of 15 degrees. The second is the degree of latitude with no plus or minus, so the tilt sits at 35 degrees. Thirdly, the degree of latitude of 35 degrees plus 15 degrees. To obtain the optimum tilt, we used the smallest irradiance value from all three categories and chose the highest of the three values. This value came to be 4.85 at Latitude Plus 15 degrees Tilt, (4W-hr/m<sup>2</sup>/day).
- Fig. 4 depicts the surface tilt and the insulation from a calendar year.



### Results

Once the parameters of the PV modules have been calculated and satisfied the charge controllers specifications, we obtained the following: 18 modules in total with 6 strings of 3 modules in series. The series modules open circuit voltage total is 120.3 V with a short circuit current of 77.7 A. With these values it is safe to say that the voltage is well below the max input, but the amperage is high. So, two charge controllers were selected and the PV modules were separated in half. The final configuration of the PV modules is 3 strings with 3 in series for each charge controller.

### Equations

#### Inverter calculations

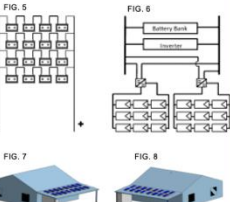
- Inverter power requirement = Peak power x (1 + design margin)
- Max. Inverter DC current =  $\frac{\text{Required Inverter power}}{\text{Nom. battery voltage} \times \text{inverter efficiency}}$

#### Battery Bank Calculation

- Average battery load =  $\frac{\text{Avg. Daily Load}}{\text{Inverter efficiency} \times \text{Nominal Battery Voltage}}$
- $C_d = \text{Days of Autonomy} \times \text{Avg. Battery Load} \times \frac{1}{\text{End of life rating}}$
- $C_d = C_d \times \frac{\text{Max inverter current}}{\text{Days of autonomy}}$
- $C_d = C_d \times \frac{1}{\text{End of life rating}}$
- DoD<sub>max</sub> = Typically 50% - 80%
- DoD<sub>min</sub> =  $100 \times \frac{\text{Average Battery Load}}{C_d}$
- $C_d = C_d \times (1 + \text{Battery Design margin})$
- Number of series Batteries =  $\frac{\text{Required Bank Nominal Voltage}}{\text{Battery Nominal Voltage}}$
- Number of battery strings =  $\frac{\text{Required battery bank capacity}}{\text{Battery Capacity}}$

### Results

- Fig. 6 illustrates the series parallel battery bank.
- Battery nominal voltage = 12 V
- Battery Bank nominal voltage = 4 x 12V = 48 V
- Battery capacity = 357 Ah @ 20 hr
- Battery Bank Capacity = 1428 Ah
- Fig. 6 Shows the PV Array modules in a series parallel connection.
- PV Module array open circuit voltage = 150V
- Short circuit = 80.1 V @ 37C
- Open circuit current = 10.36 A
- Required Power = 5.09 kW
- Capacity factor = .20
- Increase for losses = 15 %
- Temperature derating = 5 %
- PV array design margin = 15%
- Total calculated when 320 x 18 = 5.76 kW

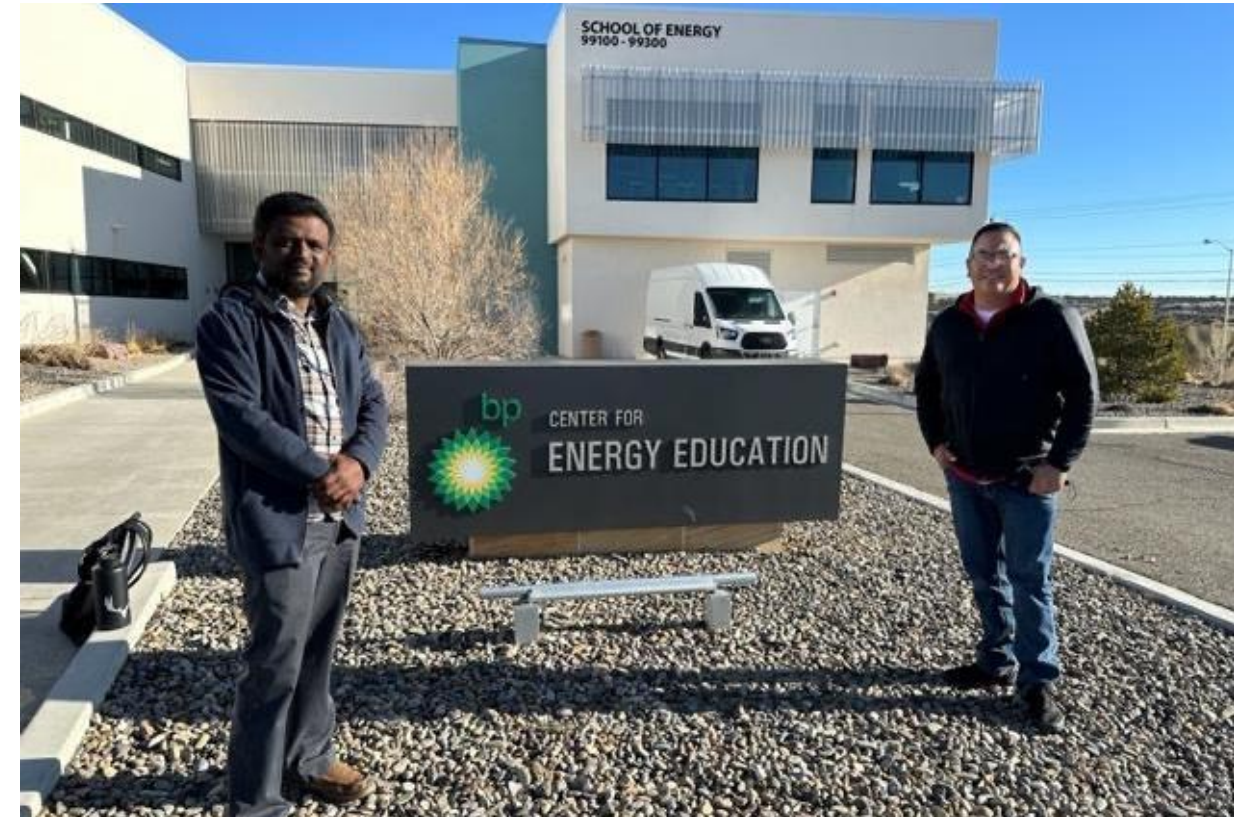


### Conclusion

With more education and advocacy for off grid PV systems it would alleviate some stress on dependency for natural resource consumptions. It would also create the Navajo Nation to become more energy sovereigns and help with sustainability in our community and across the world.

### CITES

- [1]Bridges, Thomas and Margalita, Jonathan. "Empowering Navajo Nation: How Electrification can create a sustainable future for Native country". Brookings, Washington DC, 2019.
- [2]Henry Louie, "off grid electrical system in developing countries", Springer, 2018





# Minority Serving Institution Partnership Program (MSIPP) – Annual Meeting

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“Radiation Detection on  
Abandon Uranium Mines  
on the Navajo Nation”





# Tribal Colleges and University Program Research Symposium

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- The students presented posters on various research topics.
- This symposium - growth of STEM and research.





# NTEC Navajo Mines A3 Farmington, NM

- Navajo Tech Students visit NTEC Navajo Mines A3 Farmington, NM
- opportunity to interact with industry experts.
- understand energy management



# Navajo Nation, Energy Summit 2024



## Energy Generation: Topics

- Oil and Gas
- Hydrogen
- The Importance of the Grid & Transmission, Energy Education Opportunities



50th IECON (Institute of Electrical and Electronics Engineers) conference – IEEE conference

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- **“Improving Indoor Air Quality Using a Box Fan Filter in for Navajo Nation Home - Healthy Hooghan Project”**
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10th Annual  
Tribal College  
Research  
Symposium was  
conducted at  
Bismark.

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# AIHC The American Indian Higher Education Consortium (AIHEC)



The conference featured a range of workshops, presentations, and networking opportunities, focusing on various topics





# ENERGIZED WATERSHED PANEL

**GOAL:** By 2035, the Energized Watershed Engine is a ***national*** and ***global commercial hub*** for water security and energy technologies — accelerating market-ready innovations through deep collaboration among industry partners, regional R&D institutions, Tribes, community members across the region, and investors.

## GOVERNOR'S 50-YEAR WATER ACTION PLAN

### Water conservation

- A1 Public education campaign
- A2 Agricultural water conservation
- A3 Municipal conservation
- A4 Water storage and delivery

### New Water Supplies

- B1 Desalination and water treatment
- B2 Expand potable and non-potable water reuse
- B3 Groundwater mapping and monitoring

### Water and Watershed Protection

- C1 Clean-up contaminated groundwater sites
- C2 Control discharge through permitting
- C3 Modernize wastewater treatment plants
- C4 Protect and restore watersheds

## Panel Members



David Hanson



Stephen Gomez



Alex Mayer



Ken Armijo



Sundaram Arumugam



Kurt Solander

# Navajo Technical University - Students

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Explores Sustainable Agriculture  
and Indigenous Culture in Rio  
Grande Community Farm,  
Albuquerque

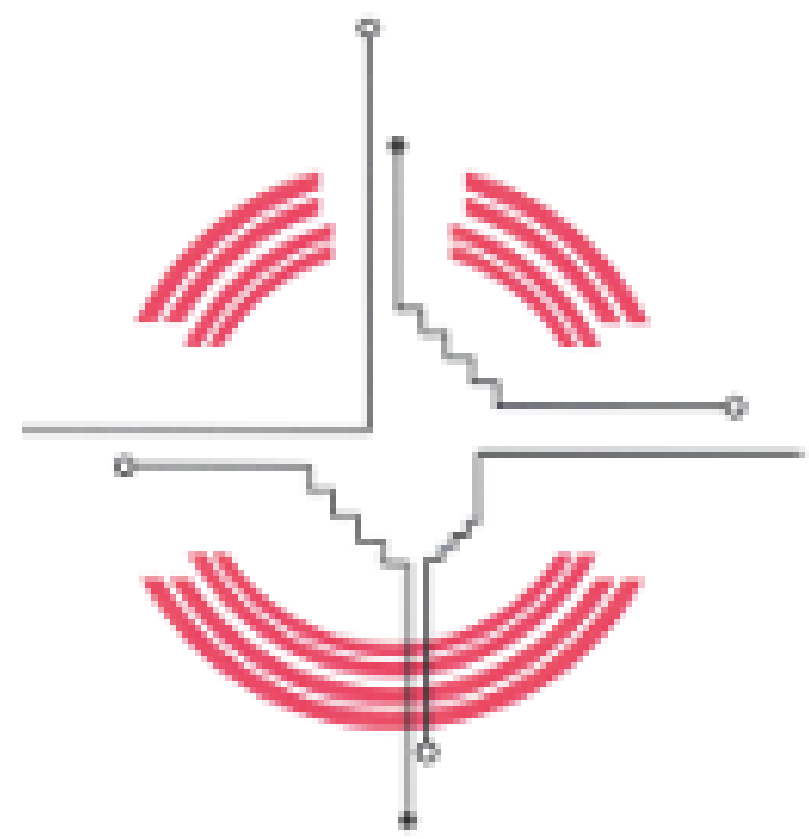




# NTU Garden Farming







Hands-on Agrivoltaic  
Microgrid Solar Panel  
Characterization Workshop  
at UNM Campus.  
Albuquerque

- Gain practical, hands-on experience in renewable energy systems through our immersive Agrivoltaic
- Microgrid Solar Panel Characterization training.

Summer STEM skill program is conducted every year for the school students and they were trained to handle the tools and use the equipment's in a safe manner.

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**JOIN US AT THE 2025 N4WPP WATER SYMPOSIUM!**

**OCTOBER 24<sup>TH</sup> 2025**

**NAVAJO TECHNICAL UNIVERSITY**

LOWERPOINT RD STATE HWY 371, CROWNPOINT, NM 87313

HIGH SCHOOL STUDENTS WILL LEARN ABOUT WATER QUALITY AND SUSTAINABILITY THROUGH A SERIES OF HANDS-ON ACTIVITIES

WE ARE LOOKING FOR ORGANIZATIONS THAT WOULD LIKE TO INTERACT WITH BOTH THE COMPETING HIGH SCHOOL STUDENTS AND THE NTU COLLEGE STUDENTS ALREADY ON CAMPUS

INTERESTED? CHECK OUT OUR WEBSITE TO REGISTER AND LEARN MORE ABOUT THE 2025 EVENT!



Energized Watershed



# Navajo Tech - New Mexico Tech - Navajo Nation Water Purification Project



Thank you